DOCUMENT RESUME

ED 152 433 PS 009 859

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TITLE Developmental Changes in the Awareness of Memory Benefits Associated with Different Types of Picture Organization.
INSTITUTION Wisconsin Univ., Madison. Research and Development Center for Cognitive Learning.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.
REPORT NO UW-RDCCL-TR-450
PUB DATE Mar 78
CONTRACT OB-NIE-G-78-0117
NOTE 21p.; Report from the Project on Studies of Instructional Programming for the Individual Student; Paper presented at the Southwestern Society for Research in Human Development Conference (Dallas, Texas, March 17-18, 1978)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Adults; *Age Differences; *Classification; *Cognitive Processes; *Elementary School Students; Intellectual Development; *Memory; *Pictorial Stimuli; Recall (Psychological); Research; Semantics
IDENTIFIERS *Metamemory

ABSTRACT

The study examined whether an awareness that semantic organization is beneficial to picture recall ("semantic enhancement") precedes an awareness that certain types of organization are more beneficial than others ("levels of processing"). A series of pilot studies was conducted with kindergarten and adult subjects and a formal experiment was conducted with first, third, and fifth graders. Metamemory judgments were elicited by having subjects judge the relative ease of recalling a 3 x 3 array of pictures according to how it was organized: taxonomic category (semantically), by shape category (physically), or randomly. Actual memory was assessed with an independent list of 16 pictures, whose names were recalled after subjects sorted the list in one of these three ways. Results indicated that while all subjects understood semantic enhancement, only fifth graders and adults understood levels-of-processing. At all ages there was an erroneous metacognition that physical organization results in easier recall than a random one. It was argued that some "meta-awareness" is dependent upon specific memory experiences and not general intellectual development. (Author/JMB)

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ED152433

Technical Report No. 450

DEVELOPMENTAL CHANGES IN THE AWARENESS OF MEMORY BENEFITS ASSOCIATED WITH DIFFERENT TYPES OF PICTURE ORGANIZATION

by

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Report from the Project on
Studies of Instructional Programming for the Individual Student

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March 1978

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Center Contract No. OB-NIE-G-78-0117

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The Wisconsin Research and Development Center is supported with funds from the National Institute of Education and the University of Wisconsin.

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ACKNOWLEDGMENTS

We appreciate the help of the many schools in the Madison and Minneapolis areas that participated in the study. Thanks also to Tom DeRose who helped with one of the pilot demonstrations.

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ABSTRACT

The study examined whether an awareness that semantic organization is beneficial to picture recall ("semantic enhancement") precedes an awareness that certain types of organization are more beneficial than others ("levels of processing"). A series of pilot studies was conducted with kindergarten and adult subjects and a formal experiment was conducted with first, third, and fifth graders. Metamemory judgments were elicited by having subjects judge the relative ease of recalling a 3 x 3 array of pictures according to how it was organized: by taxonomic category--semantically (S), by shape category--physically (P), or randomly (R). Actual memory was assessed with an independent list of 16 pictures, whose names were recalled after subjects first sorted the list in one of the three ways (S, P, or R). It was found that: All subjects understood semantic enhancement, i.e., S >R, but only fifth graders and adults understood levels-of-processing, i.e., S >P. At all ages there was also an erroneous metacognition--that physical organization results in easier recall than a random one (P >R). The hypothesis was confirmed and it was also argued that some "meta-awareness" is dependent upon specific memory experiences (or the lack thereof) and not general intellectual development.

DEVELOPMENTAL CHANGES IN THE AWARENESS OF MEMORY BENEFITS ASSOCIATED WITH DIFFERENT TYPES OF PICTURE ORGANIZATION

A number of recent information-processing models posit that the recallability of stimuli is, in part, a function of the degree to which they were processed semantically (e.g., Craik & Lockhart, 1972; Nelson, Reed, & McEvoy, 1977; Paivio, 1971). In particular, "shallower" levels of processing tend to be associated with the sensory (physical) features of stimuli, whereas "deeper" levels are associated with more meaning-extracting (semantic) features.[1]

That processing at a semantic level generally leads to superior recall has been established in the verbal-learning literature. For example, Jenkins and his associates (e.g., Hyde & Jenkins, 1969; Walsh & Jenkins, 1973) typically ask subjects to perform one of several incidental "orienting" tasks while listening to a list of words. Some of these tasks focus the subject's attention on physical characteristics of the stimuli by, for example, counting the number of es or the number of letters in the word, or determining whether the word rhymes with a given target. Other orienting tasks focus the subject's attention on semantic characteristics of the stimuli by, for example, evaluating their pleasantness or unpleasantness. On a subsequent unexpected recall task, subjects who were given the semantic orienting task invariably outperform those who were given the physical orienting task, even when plausible contaminating variables are controlled (e.g., Till & Jenkins, 1973). (For one contaminating variable that has not been controlled in these experiments, but which is not relevant to the present research, see Postman and Kruesi [1977].)

Two recent studies (Murphy & Brown, 1975; Yussen, Levin, DeRose, & Ghatala, 1976) have investigated the levels-of-processing phenomenon with young children (preschoolers and first and second graders), utilizing pictorial materials. Inspecting the physical detail of a picture seems to be more central to examining it than is inspecting the physical detail of a word. For this reason pictures constitute a logical class of stimuli that might have contradicted the earlier findings.[2] However, this did not occur. Both studies indicated that orienting tasks requiring attention to the meaning of pictures yielded greater recall of them than orienting tasks directing children's attention to physical characteristics. Thus, the levels-of-processing phenomenon appears to be robust not only with respect to the

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[1] In the present paper we apply the "depth" metaphor to features of stimuli (physical and semantic) that seem to result in qualitatively different modes of information processing, as indicated by empirical research. Whether the metaphor is an appropriate one has recently been questioned by Craik and Tulving (1975) and Morris, Bransford, and Franks (1977), among others. We continue to apply it here merely out of convenience rather than out of some "deep" attachment to it.

[2] A study by Bower and Karlin (1974) included faces as stimuli, but their results cannot be directly related to the present class of common-object stimuli.

stimuli's mode (words and pictures) and class (objects and faces--see Bower & Karlin, 1974), but also with respect to developmental level (adults and children).

The purpose of the present study was to examine the development of subjects' tacit awareness of the levels-of-processing phenomenon. Specifically, we wanted to determine whether there is an age-related change in subjects' knowledge that semantic processing of pictures results in a higher level of recall in comparison to physical processing of them. The focus, then, was upon metamemory, or knowledge about memory (Flavell & Wellman, 1977), rather than upon memory capabilities per se. There has been some research examining the development of children's awareness that semantic activity facilitates recall relative to no activity or unrelated activity (Moynahan, 1973; Salatas & Flavell, 1976; Tenney, 1975). The results suggest that such awareness is present even in some kindergartners, and is fairly well developed by third grade. We will refer to this as "semantic-enhancement" awareness.

Note that the levels-of-processing distinction is more subtle than the idea of semantic enhancement. Semantic enhancement requires the simple awareness that some kind of activity (specifically, semantic analysis) is better than none. What must be understood in the case of "levels-of-processing" awareness, however, is that two ostensibly similar kinds of activity (i.e., classification of items) yield different memorial benefits. As a result, we expected that levels-of-processing awareness might emerge later developmentally in comparison to semantic-enhancement awareness.

METHOD

The hypothesis was first assessed in two pilot experiments to establish whether or not levels-of-processing awareness is something that ever develops. In particular, kindergartners were posed relevant metamemory questions in one experiment and adults were asked the same questions in another. Two additional pilot experiments determined whether the recall patterns obtained by Yussen et al. (1976) and those found in the kindergarten pilot experiment could be duplicated with adult subjects. Each of these experiments employed large samples, and each provided useful information which will be summarized before we launch into the experiment reported here. We avoid a complete presentation of the pilot work, however, so that the reader can easily separate what we view as "preliminary" from what we view as "main" findings.[3] At the same time, we do not want to minimize the real contribution of the pilot research and believe it adds perspective to the main findings based on first, third, and fifth graders.

PILOT FINDINGS

In the first pilot study, 84 kindergarten children were administered three metamemory questions and a free-recall task, with task order (metamemory/free recall) counterbalanced across subjects. The metamemory questions called for the children to judge the relative ease of recalling a

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[3] In addition, the term "preliminary" was chosen advisedly. Slight procedural and sampling errors occurred, reliability information was not obtained, and the adult recall data were collected in classroom demonstration contexts rather than in carefully controlled experimental sessions.

3 x 3 array of pictures according to how it was organized: by taxonomic category, or semantically (S), by shape, or physically (P), or randomly (R). It was found that a significant proportion of the children (73 percent) thought that the S array would be easier to recall than the R array, thereby replicating previously mentioned findings. For S vs. P judgments, subjects were approximately equally divided (the 57 percent selecting the P array did not differ significantly from chance). The final question found that a significant percentage of the children (78 percent) believed that the P array would be easier to recall than the R array.

The recall problem required that the children sort a list of 16 pictures into categories (semantic, physical or control--converting rows to columns and vice versa) and then recall all the picture names they could in any order. Consistent with our previous results (Yussen et al., 1976), children who sorted semantically recalled significantly more items (a mean of 7.68) than either those who sorted physically (5.11) or the control subjects (5.64); the latter two groups did not differ significantly.

Thus, kindergartners did not appear to exhibit levels-of-processing awareness, but they did have an awareness of semantic enhancement, as well as an erroneous belief that a physically organized list promotes better recall than a randomly organized one.

In the second pilot experiment we turned to adults, recruiting 55 volunteers from college dormitories on the UW-Madison campus. Employing the same metamemory procedure (there was no free recall problem this time), we found that a significant percentage of subjects (87 percent and 64 percent) correctly answered the semantic-enhancement question ($S > R$) and the levels-of-processing question ($S > P$) respectively. Once again, a significant proportion of subjects (84 percent) judged the physically organized list to be easier to recall than the randomly organized one ($P > R$). So, indeed, "levels-of-processing" awareness is present in adults.

Two final pilot experiments need mention. A group demonstration was designed in which a series of slides was shown to a group of college students, N = 80 in one experiment and N = 62 in the other. The slides were the same 16 pictures previously employed and used in the main experiment to be reported later. The subjects made decisions which required them to evaluate the stimuli on the basis of either semantic, physical, or irrelevant (control) criteria. The basic experiment has been repeated as a group demonstration for a large introductory class in human development for at least four different classes over the past several years. Each time, the same pattern of results emerges. Taking just the means of the two samples mentioned, subjects who made semantic decisions recalled significantly more (X = 11.48, 11.45) than those who made physical (X = 7.92, 7.48) or irrelevant decisions (X = 7.89, 6.95), while the latter two groups did not differ significantly. Thus, the pattern of recall is essentially the same for these adults as for the kindergarten children in the earlier pilot experiment. Interestingly, both children and adults believe that a physically arranged list will be recalled more easily than a randomly arranged list--a belief that is not supported by their recall performance.

Since kindergarten children do not seem to have an awareness of levels of processing while adults do, it was decided to test children across the elementary school years, to determine if such an awareness develops during childhood. In addition, the metamemory questions were modified from the pilot procedures to reduce the element of chance associated with the children's judgments, as well as to determine whether such judgments are reliable. The methodology replicates, in most respects, that of the pilot work.

MAIN EXPERIMENT

Subjects

One hundred fourteen children were selected from first, third, and fifth grade classrooms (38 children per grade) from a public school in rural southern Wisconsin. Most of the children were white and came from middle and lower-middle income farming and blue collar families. There were approximately the same number of boys and girls at each grade, and the mean ages were 6-11, 9-1, and 11-3 for first, third, and fifth graders respectively.

Design and Materials

Each child was given a series of metamemory problems, followed by a recall task. Two sets of stimuli were used, one for metamemory and one for recall. Both sets consisted of black and white line drawings representing common objects easily named by children.

Metamemory task. Nine pictures, each approximately 11 cm. X 8 cm. in size, were cross-classified to represent three semantic categories (musical instruments, tools, and vehicles) and three physical shape categories (, , and). Each picture was drawn with its predominant shape accentuated to ensure that subjects were able to distinguish it from other physical characteristics.

Three copies of the list of pictures were made, so that different visual arrangements of the list could be presented. All arrangements consisted of the pictures appearing in a 3 X 3 array fastened to a black card (38 cm. X 26 cm.), spaced to accentuate the three columns. On one card, pictures were arranged in columns by semantic category; on a second, by physical shape category; and on the third, randomly (so that no two items from the same category appeared together in the same column or row).

Recall task. Sixteen pictures representing four different semantic categories (food, body parts, clothing, and toys) and four different physical shape categories (, , , and) were used. These were identical to the stimuli employed by Yussen et al. (1976). When performing the recall task, subjects were randomly assigned to the three conditions described below.

Procedure

Each child was tested individually in a small room of his or her school by the third author. The task was introduced as a game with pictures, and administered at a table in the room. A session lasted about 15 minutes per child.

Metamemory task. Each subject was shown the three different list arrangements simultaneously by placing the cards beside one another on the table. Several preliminary probe questions were asked to ensure that the subject noticed that the same pictures were on each card, but in different orders, and to make sure that he or she noticed the different category arrangements on the three cards. The child was then asked to predict which

or the three cards would be easiest to remember if the card was removed and all the pictures on it had to be recalled. A "no difference" response was mentioned and permitted in order to reduce the element of chance in instances of uncertainty. Thus, this questio.. required the subject to decide what type of arrangement would produce the best recall: semantic, physical, or random. In addition, to increase the stability of judgments (and to permit judgments about stability), three additional questions were asked in which the child had to make all possible pairwise judgments: semantic vs. physical, semantic vs. random, and physical vs. random. The order of these questions was randomly determined for each subject, and followed the same format as with the initial question except that only two cards at a time were displayed for each question.

Recall task. The children were shown the stimulus cards in a random 4 X 4 array and asked to sort the cards in one of three ways: semantic subjects by taxonomic category, physical subjects by shape, and control subjects by converting rows to columns and vice versa. The pictures were then covered and the subjects were asked to name as many pictures as possible. The experimenter provided prompts (i.e., "Can you remember any more?") after the first two pauses in recall.

RESULTS

Metamemory Task

It will be recalled that two phenomena were of interest in the present investigation, namely what we have called semantic-enhancement awareness and levels-of-processing awareness; and, in particular, their development during the elementary school years. In the metamemory task, the choice between the semantically (S) and randomly (R) organized arrays permits an assessment of semantic-enhancement awareness, and that between the S and the physically (P) organized arrays permits an assessment of levels-of-processing awareness. With only one problem apiece tapping each metamemory area, however, the possibility of response unreliability cannot be ignored. Thus, the analyses adopted here attempt to deal with response unreliability in two ways.

First, rather than interpreting the results based on individual metamemory problems (i.e., S vs. R, S vs. P, P vs. R, or S vs. P vs. R), the information from all four problems was amalgamated to determine for each subject his or her perceived "easiness" ordering among the three types of organization. That is, each array was presented exactly three times for a metamemory judgment, and equally often with each other array. Therefore, out of the four problems, three included a particular array and one did not. With one point awarded each time a particular array was selected, and 1/3 and 1/2 of a point awarded whenever a "no difference" option was selected in the three-array or in a two-array problem respectively, a total score of 1-1/3 would be associated with each array if no easiness differences were perceived among them. A total score greater than 1-1/3 indicates that a particular array was perceived as easier to recall than would be expected, while a total score less than 1-1/3 represents a perceived more-difficult-to-recall-than-expected array. Comparisons of across-subject means permit statistical inferences regarding the present hypotheses.

Second, the three metamemory problems demanding pairwise judgments were examined to determine the "logical consistency" associated with subjects' orderings. Thus, a subject who indicated that, for example, P $\geq$ S, S $\geq$ R, and P $\geq$ R (or any other syllogistically appropriate ordering) would be classified as "consistent," whereas one who indicated that P $\geq$ S, S $\geq$ R, and R $\geq$ P (or any other syllogistically inappropriate ordering) would be classified as "inconsistent." Given these classifications, subjects' responses to the initial three-array metamemory question were analyzed. Thus, it was possible to determine whether there were age-related judgment differences even when possible consistency or reliability differences were controlled.

The results of both analyses were compatible, and will now be discussed. The mean number of times each array was selected as "easiest" is displayed in Figure 1 for subjects at each grade level. To assess the hypotheses of interest, for each subject three difference scores were created: between his or her S and R scores, S and P scores, and P and R scores. The first two difference scores were used to investigate semantic-enhancement awareness and levels-of-processing awareness, respectively. The third difference score was not central to the present study, but rounds out the investigation by determining whether these children have the same mistaken belief as our pilot subjects that physically arranged pictures will be better recalled in comparison to randomly arranged stimuli.

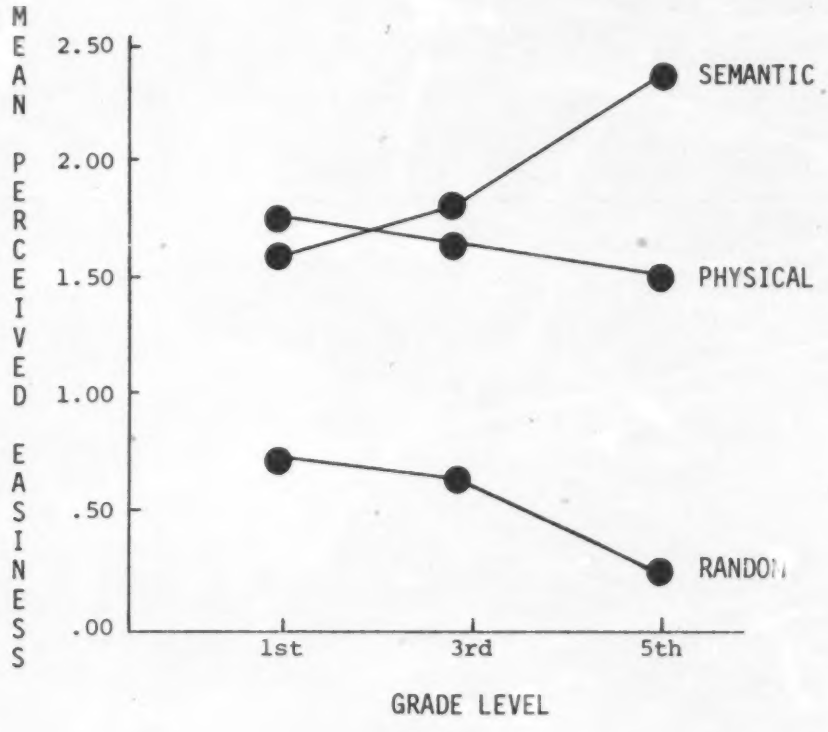

Figure 1. Mean perceived "easiness" of semantic, physical, and random arrays in children's metamemory judgments.

Each difference was examined in two ways: (1) within each grade to determine whether or not the effect was statistically "real"; and (2) in conjunction with grades to determine whether any grade-related changes occurred with respect to the magnitude of the effect. For each difference incorporated into the two immediately preceding questions, Dunn's procedure ($\alpha = .05$) was employed to assess a given "family" of three comparisons (see Kirk, 1968).

Semantic-enhancement awareness. Within each grade, the S - R difference was statistically significant according to Dunn's procedure, all ts $(111) > 4.43$, $ps < .001$. Thus, subjects at all grade levels in the present study were aware that a semantic arrangement of pictures would lead to a higher level of recall in comparison to a random arrangement. (Whether or not this judgment and the others represent correct appraisals for these particular subjects will be seen in the recall data.) The interaction of semantic-enhancement awareness with grades was investigated by comparing the S - R difference for each pair of grades according to Dunn's procedure. It was found that the S - R difference did not increase significantly between first and third grade, $|t| < 1$, but that it did between third and fifth grade, $t(111) = 4.20$, $p < .001$. This increasing S - R difference is clearly revealed in Figure 1.

Levels-of-processing awareness. As may also be seen in Figure 1, and in striking contrast to semantic-enhancement awareness, the younger children (first and third graders) do not exhibit levels-of-processing awareness (as was true for kindergartners in the pilot research). The ts associated with the S - P difference are less than one in absolute value at each grade level. On the other hand, fifth graders do seem to be aware that semantic organization is superior to physical organization, $t(111) = 4.08$, $p < .001$, at least as far as subsequent name recall is concerned (cf. Morris et al., 1977). As with the previous interaction analysis, the increase in awareness is localized between third and fifth grade, $t(111) = 2.57$, $p < .011$.

Other awareness. Finally, consistent with our pilot findings and with the impression gained from Figure 1, subjects at all grade levels believed that a physical arrangement of the pictures would be more beneficial to recall than a random arrangement, all ts $(111) > 5.68$, $ps < .001$. There was no hint of a change in this awareness as a function of grade level, all ts < 1.61, $ps > .10$.

Consistency analysis. As indicated earlier, a second analysis was conducted in which subjects were classified as logically "consistent" or "inconsistent" on the basis of their responses to the three pairwise array questions. According to this procedure it was found that logical consistency was in fact age-related, with 58 percent of the first graders, 82 percent of the third graders, and 92 percent of the fifth graders exhibiting consistency, $\chi^2(2) = 13.25$, $p < .005$.

The responses of "consistent" subjects to the three-array problem are presented in Table 1, which will be shown to duplicate the previously discussed results.[4] In this table, "no difference" responses were divided

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[4]These data will be treated descriptively only, due to the ad hoc nature of the analysis and the comparatively small cell frequencies of Table 1.

TABLE 1

NUMBER OF CHILDREN CHOOSING EACH RESPONSE OPTION OF THE THREE-ARRAY PROBLEM, BY GRADE LEVEL

Response	GRADE LEVEL		
	First	Third	Fifth
Semantic	9 (41%)[a]	16 (52%)	23 (66%)
Physical	10 (45%)	11 (35%)	11 (31%)
Random	3 (14%)	4 (13%)	1 (3%)

[a]Within-grade percentages are in parentheses.

equally among the three-array options. Concerning semantic-enhancement awareness, children at all grade levels expressed a preference for the semantic over the random arrangement, and the proportion doing so increased with grade level (75 percent, 80 percent, and 96 percent for grades one, three, and five respectively), just as in the complete analysis. Similarly, there was a developmental increase in levels-of-processing awareness, as reflected by the proportions of children favoring the semantic over the physical arrangement (47 percent, 59 percent, and 68 percent in the three grades). As a result of this supplementary analysis, then, it cannot be argued that the previously discussed patterns in Figure 1 reflect simply the superior understanding of "easier to recall" on the part of older subjects. Even when this variable is controlled for by restricting our attention to subjects with logically consistent metamemory responses, the same patterns are produced.

Recall Task

The summary data for the recall task are presented in Table 2. Within each grade level, the pattern of recall means closely parallels that previously reported with children (Yussen et al., 1976; and the pilot study) and adults (the pilot studies) using the same materials. An unweighted means analysis (Kirk, 1968) performed on the contrasts of interest here revealed that across grades, subjects in the semantic condition recalled significantly more than those in either the control, $t(105) = 3.86$, $p < .001$, or the physical, $t\ (105) = 3.60$, $p < .001$, condition.[5] These results cor-

[5]Within-grade analyses were not performed because of the greatly reduced cell sizes (and statistical power) associated with the three experimental conditions of the recall task.

TABLE 2

SUMMARY DATA FOR THE RECALL TASK

Grade Level	SORTING CONDITION					
	Semantic		Physical		Control	
	M	SD	M	SD	M	SD
First	8.28	2.73	5.75	1.91	5.67	1.61
	(N=14)		(N=12)		(N=12)	
Third	9.07	2.64	7.62	2.66	7.91	1.51
	(N=14)		(N=13)		(N=11)	
Fifth	11.31	2.06	9.69	1.75	9.08	2.68
	(N=13)		(N=13)		(N=12)	
Unweighted Mean	9.55		7.69		7.55	

roborate the semantic-enhancement phenomenon and the levels-of-processing phenomenon respectively. Further, no developmental changes in these recall patterns were noted in the age range represented here, as all interaction contrasts representing the two phenomena were negligible, all $|t|s < 1.15$, $ps > .25$. Finally, as may be seen in Table 2, there is no basis for concluding that physical processing of the present pictures results in recall any different than that produced in the control condition, $|t|s < 1$ for main effect and interaction contrasts. Thus, the present children hold the mistaken impression that physically arranged pictures are better recalled in comparison to randomly arranged pictures. Moreover, this false "meta" apparently dies hard, as the adults of our pilot research also clung to this belief which (according to their recall data) had no basis in fact.

DISCUSSION

The major hypothesis of the study was confirmed. An awareness of the levels-of-processing phenomenon is a metacognition that appears later developmentally than an awareness of semantic enhancement. Children from kindergarten through third grade understand that a list organized semantically will be easier to recall than one organized randomly. But not until fifth grade do children understand that a list organized by semantic categories will also be easier to recall than one organized by physical categories.

The term "semantic enhancement" is useful to describe the present results and also those of other investigations. For example, Moynahan (1973) and Brown (in press) have also demonstrated that children as young as five

or six years of age judge a semantically organized list to be easier to recall than a randomly organized one. But the term is misleading in one respect. It may be that what children "believe" or are "aware of" is that "some organization is better than none," regardless of whether the organization is semantic. This alternative notion of what children know is buoyed by the unexpected result that appeared in the main experiment and in each pilot inquiry--the judgment that the P list would be easier to recall than the R list (P > R). The likelihood of this judgment (P > R) was just as great as the likelihood of the other relevant judgment (S > R) for children of all ages, and even for adults if one considers the paired comparison questions only. Perhaps a general term such as "organization-enhancement awareness" more appropriately fits the results. This more general awareness is, of course, a non-veridical one because not all forms of organization do facilitate memory. The physical categories of the present study are a case in point. The organization-enhancement awareness, then, is an overgeneralization and one that is quite persistent. Even adults overapply it.

A frequent criticism of metamemory research is that the cognitive awareness assessed by investigators is a fleeting, ephemeral entity (e.g., Brown, in press). A child may judge the memory situation one way on one occasion and offer a contradictory opinion on a second occasion. How, then, are we to pinpoint what the child really knows or thinks? A good example of this is an anecdote offered by Yussen and Levy (1975). Preschool children asked to predict the longest series of pictures they could recall sometimes predicted successful recall of a list with n items after having just predicted unsuccessful recall with a list of n-1 and n-2 items (see also Brown, in press). Although we have no clever solution strategy which may be generally applied to measurement problems that crop up in metamemory research, we have attempted to deal with one aspect of the reliability (consistency) of children's judgments in the present situation. As one might predict from other observations (e.g., Markman, 1973; Yussen & Levy, 1975) there was a developmental change in consistency, with the children's responses becoming more consistent (in a logical, syllogistic sense) as they become older. Even when the "inconsistent" children were eliminated, however, the same developmental pattern appeared for the metamemory judgments. Thus, the findings cannot be dismissed on the basis of differential unreliability of judgments.

Finally, the accuracy of subjects' beliefs about recall were related not only to developmental differences but to stimulus differences as well. Thus, it is not sufficient to say that older subjects' metamemory judgments are more accurate than those of younger subjects across all situations. Although levels-of-processing awareness seems to emerge with age, semantic-enhancement awareness is evident even in young children. More importantly, judgments about the ease of recalling physical vs. random lists do not reflect recall reality at <u>any</u> age, even among adults. The implications of this are therefore similar to those of Levin, Yussen, DeRose and Pressley (1977) who detected no developmental increase in subjects' ability to assess their recognition (as opposed to recall) memory capacity. Their conclusion was that certain kinds of metamnemonic awareness may never develop spontaneously, or at least not without some amount of deliberate experience with the kind of memory being tapped. Assuming that subjects have only infrequently (if ever) adopted a physical organizational strategy for recalling names of pictures or objects, the same kind of "experiential deficit" explanation can be proposed here.

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